

A
LECTURE
OF
ANATOMY,
AGAINST

The Circulation of the Blood ;

Read Publickly

At *Exeter Exchange*,

The Sixth of *November* last past.

By *Dr. Joseph Browne*.

Nihil magis difficile est, quam semel insitam & ab omnibus susceptam opinionem evellere, novamque introducere, Jul. Cæs. Arantii.

L O N D O N,

Printed for *John Chantrey*, at the *Pestle and Mortar*
without *Temple-Bar*. 1701.

TO
His Excellency,
THE
HEER VRYBERGEN,

Envoy Extraordinary from the

STATES GENERAL

SIR,

THE Honour I have of knowing you, makes me ambitious of taking the first opportunity to publish it to the World; but when I come to excuse my self for offering a Subject of this Nature to your Protection, I must entirely cast my self upon your universal Candour and Affability to all Persons, and which I am more particularly sensible of: Besides, the great Value and Esteem you have expressed, in the most obliging manner for the English Nation;

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tion; and those Civilities you have always paid them, makes me not a little vain to imagine you will pardon this freedom in me; and to plead for my self, I know I cannot do it more gratefully, than by making a Publick Acknowledgment of the profound Veneration, the sincere and hearty Affection of Loyalty and true Obedience I have for his present Majesty, with the justest Thoughts of his Glorious Ambition of doing universal good to Mankind; of his unimitable Vertues, and truly Heroick Actions, that have surpass'd all the Stories of old, in their unparallel'd Circumstances: And to which August Monarch you have now the Honour to be employed by their High and Mightinesses, at such a Critical Juncture, when the happy Union of those two powerful States, enable them to poise the Ballance of the Western World.

Now Sir, I must beg leave under the Protection of your^d Character, to shelter my self from the approaching Storms, that threaten me already with an universal Deluge of Opposition; for the ensuing Sheets being filled with Novelty and Singularity against the common received Opinions, as well of the Learned, as the Multitude, I must either stem the circulating Flood, or be born down with the Torrent of the Tide; or to speak more plain, having attempted to oppose the received
Notions

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Notions concerning the Circulation of the Blood ; I must expect to be attacked and batter'd from all hands, unless I find some safety in your kind Protection ; which either the Candour or good Breeding of my Adversaries must admit to one of your Figure, and particularly, that has the Honour to be so employed by such a wise and powerful State, who count it their chiefest Glory to be our Friend and Ally. I have nothing now to ask, but hope the perusal of these few Sheets, will not long interrupt your important Business, but you will candidly accept this from,

Sir,

Nov. 28.

1701.

Your Excellency's most

Obedient Servant,

Joseph Browne.

The

T H E

P R E F A C E.

I Know it is expected, that I should give some account of the Reasons that induced me to undertake this Subject against the Circulation of the Blood, which has been demonstrated beyond all Contradiction, and that by all the Learned since it was first received: And in the next place, why I made a Publick Lecture of it, and denied several Eminent Physicians and Surgeons Admission, without they would pay something toward the Charges of their coming in? To this I answer, that I did not think myself any ways obliged to the Publick, so as to inform them of their Errors, or confirm them in the Truth of what they had before received, only to gain the Reward that is generally given to such Men as pretend to teach the World at their own Costs, viz. to be laught at for my pains. And though several Gentlemen of Worth and Learning, desired me to proceed upon this same Lecture, I declined it, upon the account I found it impossible to please the Town;

Town ; for either I must admit all sorts of People, or else only particular Persons, who notwithstanding grumbled to contribute any thing towards the Charges I was necessitated to be at ; and besides, I was unwilling to give any further disturbance to the Surgeons, who appear'd to be in a general uproar, till such time as I had made this publick : which I now throw into the World, with full assurance it will meet with hard usage, if not ill Treatment from abroad. But to show, I am not so fond of the Brat, but that upon better Grounds and Reasons than I have yet found out, I may disown it ; I here expose it naked to the World, That truth may only justify it. But I find some that understand nothing of the matter so fond of their darling Circulation, that they are half distracted, lest the People should turn Apostates from this blind Faith. The Surgeons cry out, great is Diana of the Ephesians, for fear the Craftsmen should want Employ, and Blood-letting sink with the Notion of Circulation. But to give you the reason of this Undertaking, I must declare freely ; Making some Enquiries after a nearer conveyance of Urine, than by a total Circulation, or at least through the Lacteals, the Heart and Lungs ; and having occasion more narrowly to reflect upon the Circulation of the Blood, particularly according to the manner and cause of it, as assign'd by Harvey, Lower, and the rest.

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I was puzzled the more I thought upon it, and having no design in my head to oppose any received Notions, either of the Moderns or Antients, upon my own Suggestion, I totally declined that Enquiry, which for some time gave a stop to my other design of discovering a passage by the North-pole, I mean of a quicker passage for the Urine; this I do, purely to show you how unprejudiced I am in my Opinion, as to this Affair; and likewise to show how easie and susceptible I am of a stronger impression, and do declare here, I will not willfully shut my Eyes or Ears to be convinced by any means that I am in a Capital Error, and like to be expunged the faculty, if I continue in my Infidelity; but accidentally stumbling on that Essay of Mr. Hill's, against the Circulation, it revived my former doubtings, and I then found I had no ways left to clear my thoughts of 'em, than by this design of venturing, rather to expose my self to the Censure of the World (how peevish soever it may be) than want the true knowledge of what I so earnestly desire, and have industriously sought after. I wont say, but being too hasty in my Enquiry, I may have ran too fast for the Circulation, but then I shall fancy my self hot-headed indeed, which would be a most convincing Argument, to perswade me to embrace the swiftest Notion of Circulation: But notwithstanding this, I cannot be perswaded, that all the Proofs urged by the Circulators,

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tors, amount to any more than a Motion in the Blood, which is not always one and the same; but sometimes that it Fluctuates sometimes is Progressive, but never that the whole Mass moves in Circulum; for granting that it should be supplied by the Chyle, which is brought there by another sort of motion than what is supposed in the Blood, and from another cause, yet it is not circular, and supposing still that that Blood passes into the right Auricle of the Heart, and so through the Lungs, and is then by degrees transmitted to the other parts of the Body, as there is want, and as the Nutrition of the parts require; and supposing on, that some of this Blood be in process of time carried back again to the Heart, yet this does not prove such a Circulation as contended for, nor a total Circulation of the whole Mass; not confining it to any time, as taught us by all the Circulators; and which is performed, as they say, by Contraction and Expulsion, and from the Arteries into the Veins.

Now I would not have the Reader misunderstand me; for what I have here contradicted is, the Circulation, as agreeable to the several Systems of Harvey, Lower, Wallæus, and the rest that have wrote on their Notions; nor against any new System that may hereafter be suited better to the Reason and Nature of the thing. I cannot be supposed to contradict what I know not; but shall be infinitely glad to find these Notions better explained, and

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and such a Circulation proved of absolute use and necessity to the *Animal Oeconomy*, and whereby we may more clearly understand and account for the Disorders that shall happen therein. If this be not a fair declaration of my Sincerity for the Truth and real knowledge of what I here contend for, I must disclaim making any; and without any further Ceremony, deliver this up to be impartially tried by its Peers. Indeed I did not meet with that candid Usage, I might justly have challenged from my Audience, who abruptly, and as it were with too much heat and violence for Truth, opposed every Sentence I deliver'd, not giving themselves time to think maturely before they spoke; such was their Passion and Zeal to espouse the cause. Some through Ignorance or Heat, denyed my Quotations, which are still the same, and the Reader may at leisure be satisfied in; others denyed matter of Fact, and some offer'd to show the Experiments quite contrary, but have not been so just to me, as for their own words, yet make good what they publickly promised to do. It is natural enough for every Man to justify his own Actions; and I know no reason why any Man should be so far wanting to himself, as not to do it, lest the World should think he is too much in love with his own Performances, and his modesty might plead better for him, than the assurance of his own justification, but I think it too late for a Man to pretend to such kind of modesty, when

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when he has taken upon himself, to stand the mark of the Publick, and oppose his own Sentiments with assurance, in a matter, wherein the general Opinion of the World is against him: I say, it is too late for such a one to make these sort of pretences, when he was launced out into the deep, and ought then to imploy his whole endeavours to keep himself above Water.

And since I am mentioning the doing of justice to my self, I must not omit the taking notice of that Epistle spread about the Town, and dedicated to the Men of the House in Warwick-Lane, by Mr. Hill, in his second Essay against the Circulation; and I think my self here obliged to satisfy the Publick, that the making use of my Name in that Epistle, was contrary to my Knowledge or Approbation, though some have been pleas'd to reflect upon me as privy to it, and not only so, but that it was done by my direction; all which I do here deny. And because some others have made themselves very busie with my Name in Publick, I must beg leave of the Reader to pardon this digression, whilst I give a very short account of the Proceedings of some of the Dispensary Doctors of the College, when I published Sir Theodore Mayerne's Works; a Person who had been a very considerable Benefactor to the College of Physicians, though once that Society had used him very scurvily, as appears from his own Papers. It was about 3 Years ago, when I published Proposals for Printing these Phys-
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sical Works ; and then I addrest my self to Three of the ruling Party of the College, who all promised me they would assist me with the best of their service ; which I readily accepted of : and accordingly they promised me to get the Subscription of the whole College ; but in a little time, after many of these wheedling Promises, one of them declared, if I would let them come in to the Profits of the Copy, they would procure what they had promised, otherwise they could compel me, by summoning me before the Censors Board, to commit the overseeing of the Sheets into their Hands, and that I could not Print it without their Consent and License ; but finding that threatning prevailed nothing upon me, and fearing that they might have discovered themselves too bare-faced ; they requested me to address my self to the Censors Board, from whom I expected more candid usage, upon the account of the Author ; being indeed unwilling to publish so great a Work, without a general Approbation. And because they had recommended to the World, a mangled Piece of Receipts of his, which they cut off from the Cases that preceded the Directions, and published them under the Title of Praxeos Mayernianæ, of which I think they have all reason to be ashamed ; for a much better piece might have been cull'd from the Files of any Apothecary in Town, and done less dishonour to his Memory, who left the greatest Name of Riches and Learning of any Physician since the

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Days of Hippocrates. But to return to the College again, the President and Censors desired me that I would communicate my designs to the Censors Board, and they would consider of my Proposals at a general Meeting; when they did not doubt but every Member would subscribe to the Printing of a Work, wherein the Honour of Sir Theod. Mayern, who had been so good a Benefactor, might be reviv'd; but withal, desired me to come again the next Meeting, which I did: but no sooner was I come, but I was called in, where they were all ready to pronounce my doom, and with open Mouths to set forth their Authority; so that instead of encouraging the Work, they were all ready to affright me from proceeding in an Affair, which was only fit for them to undertake (as they would have perswaded me to believe) but that I knew their Authority and Performances were of equal Esteem in the World; that is, no body much regarded either.

Thus I was used by a Body of Men, who ought to have had a greater Veneration for Learning, than to discourage such a one as was freely willing to declare his whole intentions to them, and be directed by their Advice. But I shall decline this ungrateful Subject, and pursue the business in hand. In order to which, I must oblige my Reader to observe diligently, how well the Circulation has been improved, and how the Moderns reason from it. And here by the By, I shall examine

Dr.

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Dr. Cockburn's Profluvia Ventris, pag. 27. Where he argues thus.

And because the Pulse is that affection by the Blood, whereby at every Contraction of the Heart, the Arteries are filled, and their sides are brought outwards; and this filling of Blood by the influx of Spirits into the Muscle of the Heart, the Pulse must be frequent and slow, proportionably to the Contractions, great, little, and depressed, as the Artery is filled. Now by all the foregoing appearances, there is a greater quantity of Blood, even to a smaller Separation of Spirits for some time, which quantity flowing in greater abundance into the Ventricles of the Heart, and thence into the Arteries in the same time; and into the Arteries after such a manner, that the whole quantity of Blood that was determined by the last Contraction, is not convey'd in its own force in the Persistole, and when the next Contraction does begin, which makes that imperfect Dilation of the Artery, with so great a quantity of Blood, which is a depress'd Pulse. Herein I have given you a taste of one of our Modern Circulators fine strokes, to let you see, how well he seems to understand the matter which he here pretends to explain, because he sets up for a great Stickler, and a Champion for the Cause. I would desire the Reader to learn what he means by the Pulse, that he says it is that affection by the Blood; for I must confess, I cannot understand him; but whether

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ther it is, that I may be too great a Novice in my Mother Tongue, as not to understand English, or that he writing on too sublime a Subject, may not understand it rightly himself, I leave the Reader to judge. But he goes on, and by this means finds, that at every Contraction of the Heart, the Arteries are filled. I doubt not, and believe he will never be able to prove they are, and then he might as well have said nothing. But he has made a new Discovery; that the sides of the Arteries are brought outwards. I hope he does not mean that the insides are turn'd outwards; but what makes all this to a depressed Pulse? This filling of Blood by the influx of Spirits into the Muscle of the Heart, the Pulse must be frequent and slow proportionably to the Contractions, as the Artery is filled: but how comes the Blood to fill the Heart by means of the animal Spirits? As I suppose these are which he means, since they act here only upon the Nerves, though I wish the Doctor might be obliged to prove they act here at all; and if they do, they cannot contract the Heart ofner than it is supplied from the venal Blood; and the Heart if it contracts itself at all, undergoes that Contraction long before the animal Spirits can be supposed elaborate to send in their influx; and then what needs these far-fetched Notions, to solve an Hypothesis, by which they can solve nothing else. But now he concludes very strongly from these appearances, that there is a greater
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quantity of Blood, even to a smaller Separation of Spirits for some time, and that the whole quantity of the Blood that was determined by the last Contraction, is not convey'd in its own force in the Perfistole; and when the next Contraction does begin, which makes that imperfect Dilatation of the Artery, with so great a quantity of Blood, which is a depress'd Pulse. Here you find the Doctor a most accurate Observer of Nature, and can tell you when the Blood moves by its own force, and when it is moved by anothers: Now if the Blood has a force of its own, which I never knew before, what need there be any Contraction of the Heart, since it can dilate itself as occasion serves, and convey its own Body where it lists? And it must have a force of its own, else it could not lose what it had not: But supposing all he says for granted, can there be a perfect Dilatation from so great a quantity of Blood? I doubt he mistakes, or knows nothing what Dilatation and Contraction means; for too great a pressure must make an imperfect Contraction, and the Dilatation much greater. For I do affirm, when the Blood presses in too great quantities, neither the Heart nor Arteries can contract themselves so vigorously, as with less quantities. If I could allow a Contraction or Dilatation from the pressure of the Blood, or by means of the Blood as Blood. The next thing I shall mention from this learned Advocate of Circulation, is his fine speculative Reasons
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for Death, pag. 38. prof. ven. 'Death being that
'Condition of a Man, when there is no more a Circula-
'tion of our Blood; which only can happen naturally,
'from a sufficient quantity of Spirits, to keep up the
'fluxility of the Blood, and to give Spirits to the Heart.
If this Gentleman thinks that Death immediately suc-
ceeds a stoppage of Circulation, Life must indispensably
depend upon it, and then I will refer him to the Argu-
ment upon Amputation; and if that can give no satisf-
faction that the Circulation is impeded, nay totally in-
tercepted, I will desire him to give me an account how,
when any one faints or swoons away, and continues for
20 or 40 hours, void of all perceptible heat and mo-
tion, whether he thinks Circulation is continued, and
that when they return, it is actually from Death to Life
again: an instance of this I can give of one who lay
48 hours motionless, and void of all heat, and
which by the use of the hottest external Applications,
could not be procured that no Blood would issue forth,
though the Veins were cut in several places; and that
there was not the least appearance of a motion, either
from the Heart, or by the Breath; and of another, whose
Artery was cut in sunder in an Apopleſtick Fit, and
notwithstanding bled not till two hours after the Orifice
was made, when on a sudden it rush'd out with violence,
and the Patient at the same time shrick'd out, and the
Blood stopt its motion again, for near the space of a Mi-
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nute, afterwards when the Arm had bled plentifully, it was tied up, and the Party recovered his Senses in two hours time.

I gave these Instances, to show Diseases are not so accurately accounted for, by this Hypothesis of the Circulators, as they have imagined; but on the other hand, some have been more puzzled to discover the Principles, from whence they pretend to account for the various Phænomena, than to explain the Cause and Nature of the Diseases themselves: But as I shall not engage my self any further in this dispute at present; so I shall not decline the prosecution of this Subject, till I have given some satisfaction to the World, that if a Circulation can be maintain'd, it must be upon a new and better Basis than that on which the present Hypothesis is raised; and I do earnestly desire, that whoever attempts to maintain the Doctrine denyed in the following Sheets, would be pleased to reflect and think maturely upon the variety of Anastomoses and Inosculations that are found every where between one Artery and another, whilst those between the Arteries and the Veins pass yet unseen; whereas on the other hand, if he can discover one Inosculation between a Vein and an Artery, saving in the Liver, it will be altogether new, and will help to convince me of my Error: Nay, this general Union that appears to be every where with Arteries amongst themselves, will introduce a new kind of Circulation,

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culatation quite destructive of the Old. But this I hint upon, barely to imploy your thoughts, how to extricate your selves out of the Labyrinth of a new and old Circulation, if you prove either the one or the other reasonable and absolutely necessary. I shall only mention one particular and very remarkable Inosculation of the Pulmonary Artery with the Bronchial, and which I had pass'd by without any notice in the Lecture, see Fig. 6. for the Bronchial Artery is united by Anastomoses in several places to the minutest Ramifications of the Pulmonary Artery; and for a social Vein to this Bronchial Artery, that accurate Anatomist, Frederick Ruysch, has not yet been able to determine with certainty; and indeed there seems not to be any necessity for one here any more than in the Liver, where the Hepatic Artery has no peculiar Vein attending it.

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EXPLANATION OF THE FIGURES.

FIG. I.

R Represents the Difference betwixt the *Vena Cava*, and the *Aorta*.

AA The *Vena Cava*, which being measured, is near 3 times as big as the *Aorta*.

BB The *Aorta*.

C The Emulgent Vein, bearing the same unequal Proportion to the Artery, as the *Cava* does before mentioned.

D The Emulgent Artery.

E The Kidney.

FIG. II.

Shows the right Ventricle of the Heart, cut open from the Auricle to the Cone of the Heart, and from thence to the Pulmonary Artery, to show how much larger its Capacity is than that of the left.

AA The Ventricle of the Heart laid open, that the contracting Nerves or Fibres of it may appear.

BB The thickness of the Sides of the Ventricle.

C The right Auricle.

D The

D The Entrance into the Pulmonary Artery.

ee The Coronal Arteries.

F G Shows the length of the Ventricle from the Basis to the Cone.

H H The breadth or capacity of the Ventricle.

I I The thinness of its sides next the *Septum*, towards the left Ventricle.

F I G. III.

AA The left Ventricle of the Heart laid open, to show the smallness of its Capacity, to that of the right Ventricle.

B The left Auricle.

CC The thickness of the Sides of the left Ventricle.

D The Entrance of the Coronal Artery.

EE The Semilunar *Valves*.

FF The Coronal Arteries.

F I G. IV.

AA Two Glass Bodies fill'd with Water.

BB Two Cranes of unequal Size immersed in the Water.

F I G. V.

AA Glass Tube laid Horizontally, and fill'd with Water.

B A Pipe proceeding from it vertically.

C A pair of Bellows, which by blowing, throws all the Water out at the Pipe B, except you put a Nose upon the Bellows, with several small holes in it, which will then only pervade the Water in its passage through, and the Wind make its *exit* at the Pipe B.

F I G. VI.

A A Branch of the Pulmonary Artery.

B A Branch of the Bronchial.

CCC Inosculations of the Branches of the Pulmonary Artery, with those of the Bronchial.

*A Lecture of Anatomy, against the Circulation of
the Blood, &c.*

I Cannot tell better how to Apologize for an undertaking of this Nature, than to proceed directly in the most plain and succinct Method I can, to show the Modern Hypothesis of Circulation; according to the Doctrine of *Harvey, Lower, Wallens, de Baik*; and that last of all built on the Notion of Pressure. And herein I will methodically lay down their Arguments and Experiments, and on the contrary, answer every one of them by other Arguments and Experiments; together, with such of their own, as may be made use of to confute themselves. And here by the by, I must beg leave to do Justice to the Author, of that which the Town calls a mad and foolish Essay, against the Circulation of the Blood, who reviv'd my former doubtings on these thoughts, and though some of them are but bare hints, yet, I hope they may in time be improv'd to some thing of more solid reason. I must confess, I never could rightly understand what the Circulators meant, or to what ends this Hypothesis tended, and I was glad to find some others in the World, made a doubt of what I could not clear from the best of my unprejudiced Reasoning; so that I soon gave my assent to several of the Difficulties rais'd against Circulation, and a distinct Pulsation by Intervals. In the next place then, after I have delivered the Circulator's Doctrine, and subjoyn'd my Reasons for the disbelief of it: I shall proceed hereafter to account more clearly for the Diastole and Sy-

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stole of the Heart, and several Phenomenon depending on
 the same, from Reasons and Experiments more agreeable
 to Nature, and more intelligible to our Understandings.
 I will endeavour as far as I am able, to convince the
 World, wherein the Error and Mistake consists, and shew
 what Pulsation is, or what is the efficient Cause of it,
 both in the Heart and Arteries, and then will demonstrate
 what sort of Motion that is of the Blood, and in the Blood.
 And now I am so far from thinking all that heard this Le-
 cture, as well as those that read it, will presently under-
 stand what the Circulation means, and consequently, will
 need no further Information, that I must beg leave to
 take the Freedom to say, I don't believe any one Person
 can tell what it is, without he understands more of it,
 than any of the Authors of the Circulation ever did, and
 has form'd to himself, a Circulation upon better Grounds
 and Arguments than any he can deduce from the first In-
 ventors. The World I am sure is not as yet, nor has it
 been made truly sensible, what prodigious Difficulties this
 Doctrine of Circulation labours under; else the belief of
 it had never spread itself so universally: But that is no
 Argument, but that it may be both absurd and contra-
 dictory to common Sense and Reason, for it fares with
 Physick as with Religion, in which there has been no No-
 tions so absurd and ridiculous, but they have had their
 Votaries; witness the Mahometan Religion, which has
 spread itself further than the Truth of the Gospel; and
 how many other inconsistent Notions do we see daily re-
 ceiv'd, either through Novelty or Singularity. The
 World has yet remaining so much folly or madness, call it
 which you please, that even an *Asgill* can gain some Pro-
 selytes, how ridiculous soever they may be thought. First
 then, for the Opinion of Dr. *Harvey*, whom we will not
 rob of the Honour of bringing this ingenious Hypothesis
 into the World. His Doctrine, as most of the Circulators
 must

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must do, consists of Contraction and Expulsion, Harv. pag. 48. cap. 5. *Primum sese contrahit auricula, & in illa contractione sanguinem contentum, quo abundat, (tanquam venarum caput, & sanguinis promptuarium & cisterna) in ventriculum cordis conjicit, quo repleto cor sese erigens continuo omnes nervos tendit, contrahit ventriculos & pulsum facit, quo pulsu immissum ab auricula sanguinem continenter protrudit in arterias; dexter ventriculus in pulmones per vas illud, quod vena arteriosa nominatur, sed revera, & constitutione & officio, & in omnibus arteria est; sinister ventriculus in aortam & per arterias in universum corpus.* The Auricle (says he) first of all contracts itself, and in that Contraction, throws out the Blood with which it abounds, (as the head of the Veins, and Cistern of Blood) into the ventricle of the Heart, which being fill'd with it, the Heart erects itself, and stretches continually all its Nerves, then contracts its Ventricles, and makes Pulsation; by which Pulse, the Blood sent from the Auricle, and into the Ventricle, is propell'd into the Arteries; out of the right Ventricle into the Lungs, by the Vessel call'd the arterial Vein, but is nothing but an Artery by its function; out of the left Ventricle into the Aorta, through the whole Body. Dr. Lower's System is, that the Auricles fill by the stretching of their Nerves, and that the whole Heart dilates upon filling with Blood, and when full, pulling in their Nerves again, and contracting themselves, they press out by expulsion the Blood they had receiv'd from the Ears, upon which the Heart contracts, and maketh a Pullation. At every Pulsation whereof, according to Harvey, first it may expel an Ounce at every Pulse, and make from One Thousand to Four Thousand of those Pulses in half an hour, as he says, pag. 88. *Cor una semihora plus quam mille pulsus facit, imo in aliquibus, & aliquando bis, ter, vel quater mille, quae major est copia quam in universo corpore contingat reperiri,* and a little

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farther (he says) *Videtur omnis quantitas sanguinea massa pertransire, de venis in arterias per cor similiter per pulmones.* And again, *Sed esto, quod non una semihora, sed integra, vel una die, utcumque velis fiat; manifestum est plus sanguinis per cor, ejus pulsu transmitti continuè quam vel ingestum alimentum suppeditare, vel in venis simul contineri possit.* So that from hence Dr. Harvey does imply the necessity of a Circulation, without which 'tis easie to prove by a progressive Motion that is not in *Circulum*, the Parts may be supplied with sufficient Aliment for their Nutrition, which is all that is necessary for their subsistence and growth; but then the Moderns that contend for a much quicker Motion, then Harvey thought of: They say the Heart expells two Ounces of Blood or more at every Systole; By which strong Pulsation it drives the Blood from the left Ventricle into the Aorta, and so round again by the Veins, into the *Vena Cava*, and the right Ear, where meeting and uniting with the *Chyle*, it returns into the Lungs, through the Arterial Vein, and is suckt up again, from the Substance of the Lungs by the Venous Artery, where reuniting itself, it runs like a Torrent into the left Ear again, and into the left Ventricle, and so round again continually. This is the Substance of this Hypothesis, which I shall explain more at large, in answering every particular part of it; and first, for Dr. Harvey's Notion of Contraction and Expulsion, which to me seems difficult to reconcile together, according to his own manner of explaining it: For nothing that is full and distended, as the Heart actually appears to be in live dissections, when replete with blood, can contract itself with that *impetus* required for the expulsion of the Blood through the Arteries, till the Heart is first disburthened of that weight, that hindered or kept back the strength of its contracting Force; as himself says, *Hinc clare apparet impulsu sanguinis arteriam distendi, ea enim dum distenditur non posset sanguinem*

nem tanta vi projicere : And we may observe that of the Stomach, it first expells, and then draws itself close, by shutting of its Mouth or Orifice. And this is agreeable to that Experiment of Dr. *Lowers*, when the Heart subsided, or as he says, the whole sides of the left Ventricle came together, pressing his finger by their Contraction ; but you must observe this Contraction was not when the Ventricle was full of Blood, which it could not be, and his finger in it : But then again, *Harvey* expresses himself very oddly on this matter. The Heart (says he) brings forth the Blood out of the *Vena Cava*, by the drawing of both its Ventricles, and so by its Pullation, and it's beating, and motion, brings it forth, and transfuseth it from the *Vena Cava*, into the great Artery. Here is a strange explication of drawing and expelling by one and the same Action, for here both Ventricles draw to receive Blood, and at the same time, and by that same Action of drawing, contract themselves to expel it : But again says he, the whole Heart dilates upon this filling with Blood, and when full, contracts itself by pulling in its Nerves, which makes Pulsation ; but Mr. *Tauvry* on the contrary alledges, that if the Blood was the Author of the Dilatation (which it must be, if by filling with it, it dilates itself. when once the Blood has mastered the spring or contracting Force, it would still keep open Doors for the following Blood, and the continual Flux would be so great, that the Muscle would never be able to recover a Contraction, for the Current of the venous Blood is always equal, since it does not flow by Intervals, or with joults as it does in the Arteries. Then *Harvey* says in another place, the Ventricles fill like Satchels or Bags, which lye open to receive, *Vel extenduntur ab hoc quod illis immittitur* : & *Wallens* ; & quando expulere ad naturalem suum statum redeunt, a little before the Ventricles drew in the Blood from the *Vena Cava* ; now they fill like Satchels, and need but suffer themselves

elves to be distended to receive it. But if they fill so easily without the necessity of drawing or an attractive faculty; why is it not more natural and easie to imagine they empty themselves so too, by running over, rather than introduce such a forceable and violent means barely to solve that Phenomenon; besides, if the Nerves contract the Heart by pulling in of their fibers, from the influx of the animal Spirits, or by any other means, it must be a very extraordinary motion in Nature, when they are so stretched by the fulness of the Blood which distends the Ventricles, and it is far more reasonable to suppose the Nerves less capable of contracting themselves, when stretched by the weight and pressure of the Blood which flows into the right Ear with one continued motion, and extended beyond the Power of pulling in their Strings, much less of expelling a greater Force; but on the contrary, to this assertion of theirs, it is found by experience, that Cramps, Spasms, or Contractions, happen not from the distension of a part, or when it is extended upon the Stretch, but rather from its relaxation, and when it has the liberty to shrink and draw itself up together, and when there is a want of heat and spirits, by which means the Nerves and Fibers languish, and run up on heaps, as Fiddle strings in dry weather contract themselves and shrink up; and if we observe when the hand is over full, or the fingers extended beyond their Power, the hand is no longer able to compress or squeeze any thing contain'd therein: But supposing still this doctrine of Contraction and Expulsion could yet be proved: If I say some hereafter by better reasons may maintain the Contraction and Expulsion of the Heart, yet that can never solve the difficulty of the Blood, that must rise with that impetuous Motion up the ascending Trunk of the Aorta, as to be able to convey it into the remotest parts with equal force and vigour. Further, if the Blood circulate by the means of the expulsive faculty, lodg'd in the Heart

or Arteries, how comes the *Vena Cava* to pulse, when other Vessels near adjacent to the Heart, and concern'd in the Expulsion, beat not at all? For if that Expulsion was equally carried on to all parts, and the impelling force was continued, other vessels through which motion should be convey'd from the Heart to the *Cava*, would bear a part in that Pulsation. As for the Notion of Pressure, as being capable to impel the Blood forwards by Trusion, through the vessels, it is chiefly grounded upon these two Arguments: First, from the structure of the Arteries, as to their thicknels, strength and size; for they are first large, afterwards being divided into many branches they grow smaller, till at last being scarce discernable they dwindle into little Pipes, or capillary Fibers: 2dly. From the structure of the Veins in which the Blood easily flows from the strait canals of the Arteries, because the Circumference and Capacity of the Arteries, is much less than that of the Veins, as you may see, Fig. 1. delineated from the Life. So artificial Fountains are rais'd, when the Water is forced by strait Pipes to rise above its level, according as the Pressure is greater or less, as may be better understood by the Water Engines made use of for the quenching of Fire: But suppose the force or pressure *à tergo* was such as was able to impel the Blood through all the parts with equal heat and vigour, it must then be equal or superiour to the whole Mass of Blood, to have power to drive it on continually; and then the *Valves* must of necessity stand always open, and so of consequence be of no use, and the Pulsation could not be as now it is by distinct Intervals; but the Motion must be continued without Intermission, and so there could be no Systole or Diastole, nor any Dilatation or Contraction of the Heart or Arteries. The next thing I object against, is the quantity of Blood, said by the Circulators to be puls'd out of the Heart in every hour, or any other measure of time, and that it passeth in such quantities,

ties through the Pulmonary Artery, and *Vesicula* of the Lungs, and is from thence transmitted to the left Ventricle of the Heart, by the pulmonary Vein. 1st. Then the quantity generally allow'd by the Moderns, is from one Ounce to two, at every Systole of the Heart, and that the Heart makes from Three Thousand to Eight Thousand of these Systoles in the space of one hour, and therefore at that rate there must pass through the Substance of the Lungs, near four Tun in the space of a Natural Day, and which may easily appear to any unprejudiced Person a greater quantity, than can be made to pass through their Substance in a Weeks time; besides all the inconveniences that must needs attend such a hasty motion: the vessels are not large enough to transmit the tenth part of the quantity in the time required, without considering the time that must of necessity be allow'd for the Passage of the Blood, through all the *Vesiculæ* and minute Ramifications of the Arteries, and the time for the Veins to suck it up again; and further, if the Blood was impell'd with such force as is necessary to circulate it with the celerity contended for, through the Lungs, or with that *impetus* they assign for its Propulsion into the Aorta, Men would be constantly afflicted with Hemoptoes, and it would be impossible to hinder the breaking of the tender *Vesiculæ* of the Lungs, for then that Propulsion would be much encreased, by the assistance of continual respiration, which according to their Hypothesis would be natural enough to imagine was only form'd for that purpose, and to force such a quick Circulation, as *Harvey* himself says, conveys more nutrition to the parts than they stand in need of, *Cum tanta quantitas nec suppeditari ab assumptis possit, sed longe major sit quam partium nutritioni conveniat.* Then if this Circulation be of no such mighty service to the support of Life (as will appear to be better maintain'd with out it) why must we invent such extravagant reasonings to

to prove what would of necessity bring along with it such insuperable Difficulties; for if Circulation can be allowed of at all, why must it be attended with such a train of inconsistent Notions? For can any Man be so credulous to believe against his Senses, that the Lungs can transmit so great quantities through them as I have mentioned, when by Ocular demonstration, he may see so much cannot be forced through the largest Vessels of the Lungs, as they would protrude in the same time through the minutest Vesicles; nay, if you use the greatest Arts in imitation of the Natural Motion of the Lungs by Inspiration and Expiration, as blowing into the Trachæa, and then pressing the Lungs, and continue to do so, whilst with the strongest Syringes you make an injection into the pulmonary Artery, you will not be able by this means to make any pass through the pulmonary Vein into the left Ventricle, much less can there be made that quantity to pass as pretended; notwithstanding some have affirmed, that there is an immediate and ready Communication. But supposing this to be admitted, a greater Difficulty will yet arise; and that is, that by this means, if the pulmonary Vein bring the same quantity in the same time, to the left Ventricle that the right Pulses out into the Lungs, the left Ventricle not being so capacious as the right, cannot admit such a quantity into it upon equal Pullations, but either such part of it as cannot be received by the left must be bestowed in the Lungs, or force its way out of the capillary Branches; or else that the left must pulse oftner than the right, which none of the Circulators do allow: besides, the inequality of the Ears and Ventricles, as to their size, must needs make an inequality of Circulation, if they reciprocally contract and dilate as the Ventricles do, for one Systole of the Ear cannot make a Diastole of the Ventricle, but it must be either as *Wallæus* acknowledges, That the Auricles pulse often for the Ventricles once, or else that Hypothesis must

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fall to the Ground. For how can we suppose two Vessels of unequal size can fill each other, if the less be moved no oftner than the greater, and the greater must be filled by every equal Motion of the less: to understand this the clearer, I have expressed the difference betwixt the two Ventricles and the Auricles, in Fig. 2d. and to illustrate this further, I shall give you the Experiment of two Cranes, in Fig. 3. Let there be two Vessels of Water, of equal size and measure, into which place two Cranes, whose bore will bear the proportion to each other, as the right Ventricle to the left; and the larger Crane will in time draw all the Water from the less; whereas, if they be made both of the same Capacity, they will continually supply each other, so long as the Matter endures; which will give some light into a perpetual Circulation: and if you please to consult Fig. the 1st. you will see the same thing illustrated, by shewing, that the Arteries are much less than the Veins, and that the emulgent Artery only answers to a third part of the Size of the Vein. But after all this, if no Blood at all come into the left Ventricle of the Heart, as Autopsy and Observation gives us reason to believe. I hope the Reader will suspend his thoughts, till some other new Discoveries and Experiments shall be able to reconcile the old ones to truth; for though the former tryals are undoubtedly true, it does not follow that every Argument concluded from thence must be so too; as in the tryal of the Ligature which *Harvey* makes use of, to prove, that the Blood moves by means of the Expulsion in the Heart, and the Vein when bound swell to a hardness, to show that that happens by stopping the progressive motion of the Blood, which of itself could not swell and distend to such a hardness, without the addition of Spirits, which as *Wallius* says, impels the Blood upwards, and *Harvey* himself acknowledges, that the Arteries swell only by means of the Spirits in them: And *De Back* says, they show themselves by their fluctuating

ting and giving motion to the Blood. Now from this Experiment I argue thus, That if the Blood was impell'd with such force as assign'd to it, in order to carry it with such celerity through the whole Body, there would be no need of a Ligature, for the strength of its expulsive motion would always thrust it forwards to the Orifice; whereas if you cut a Vein quite in sunder, it will not bleed the tenth part, as it will by the Ligature, because there is no *impetus* of the Spirits to force it out; and the expulsive Faculty pretended in the Arteries, we find quite lost in the Veins, which when bound by a Ligature, the Spirits coacervate and muster up their strength, and so by that means impel the Blood out of the Veins, by endeavouring their own exit; and *Harvey's* saying of Phlebotomy, that in swooning fits the Blood will stop its motion, argues the same thing, that without the concurrence of the Spirits which retire upon any sudden passion of fear, and the like, the Blood is not able to flow of itself, or by the assistance of any expulsive Faculty in the Heart, but there stops its course till the Orifice is healed up, and the Spirits bound in again, which then moves the Blood in its passage through it; and this shews the existence of such an impetuous Spirit, moving from the Heart through the Vehicle of the Blood in the several parts of it, which *Harvey* shews more plainly, by the cutting of an Artery, from whence the Blood leaps out with such fury, as demonstrates something of greater Power, than an Expulsion can procure, either in the Heart, or by means of the *pondus* of the Blood. Now nothing can effect such an *impetus* and rushing out of the Blood with violence, but Spirits, which if nothing else was contain'd in the Arteries, as *Erasistratus* held, the Blood would notwithstanding leap out from the very moment the Orifice was made, if there was any communication with the blood Vessels, much more now there is known to be Blood in the Arteries; for as any Vessel is emptied, there would be

a vacancy, if the Blood did not follow from other parts; by the same reason the Water does run in a Syphon, as you may see in the Experiment of the Cranes, Fig. the 3d.

Having now shewn, that the ground-work of *Harvey's* Doctrine has no solid Foundation, whereon to build such a Fabrick; and having I think made it demonstrable, that such a quantity of Blood, and in such time, cannot pass through the substance of the Lungs, I shall proceed to give some Reasons, why I cannot assent to the Bloods being pulsed thro' the left Ventricle: First, I can find no use or necessity for such a Circulation; 2dly. That in the opening of the left Ventricle of the Heart, I find no Blood, but on the contrary, that the figure or formation of that Ventricle, shews it to be design'd for another use; to wit, as a Store-house of the Spirits, it being rougher within, stronger, and more compact for that purpose, which is agreed on by all Anatomists of what other Opinion soever; which is a very strong Argument to conclude from, for that has a great deal of colour for Truth that is agreed on by all hands. My next Reason is, the necessity of some place, wherein the vital Spirits, refined from the grosser Air, may be concentr'd, and so break out into the flame, which you may call the flame of Life, to be distributed through the whole Body, for the continuation of heat and motion: and as this has been the Opinion of many of the ancient Philosophers and Physicians, so it is in effect acknowledged by most of the Moderns, though they would seem to deny it. *Erasistratus* would not allow any one to go about to convince him of the contrary; and *Des Cartes*, who though he was not the nicest Anatomist, the World will allow, I hope, that he understood well how to Reason, and may not be accounted amongst the meanest Philosophers; yet he could not think of a motion in the Blood, or of the Heart, without great quantities of Spirits, which he supposed we received from

from the Air, and which is so necessary for Life and Motion, that Fish cannot subsist without it: *Des Cartes de homine* pag. 5. *Pulmonis vero parenchyma tam rarum est & molle atque ab aere beneficio inspirationis refrigeratum, ut simul ac vapores sanguinis e dextro cordis ventriculo egredientes pulmonem intrant per arteriam, quæ Anatomicis vena arteriosa vocatur, ibi condensentur, iteramque in sanguinem convertantur, & postea inde in sinistrum cordis ventriculum guttatim decidunt. Quem si intrarent nondum condensati, nutriendo igni inibi latenti non sufficerent. Unde constat respirationem, quæ huic machine tantum utilis est condensandos illos vapores, non minus necessarium esse conservando illi igni, qui nobis ad vitæ nostræ sustentationem inest, & sine quo saltem nos, qui membris consummatiss. Constamus subsistere non possumus.* Here you find this great Man, though he could not readily find out the passage for these vital Spirits to be convey'd to their Storehouse, he found a necessity for the use of them; and I question not, but to prove as good a passage for these vital Spirits, as the Circulators can find for the Blood. For *Harvey* will have the Blood to move through the Lungs, and be strein'd by them, without any reason for it, but undoubtedly, wise Nature designed the Blood should be fed and supplied with Spirits, and that they should be carried from thence to the Heart, to be refined into a vital Flame, fit to give heat and motion to the Body. And we find *Willis* in his Book, *De accensione sanguinis*, every where admits of a *flammula vitalis*; and in mentioning of Heat, he says, *Nullo præter accensionem modo in sanguine produci & conservari potest*, that the Heart attracts the Air, appears from the Auricles beating (as *Wallæus* saith) many times before the Heart pulse once, and the Ventricles having each an Arterial Vein for transmitting of Air: though the present Circulators stiffly deny the Air we receive by Inspiration, to have any Communication with the Blood; the first Inventors were of another Opinion: and first

Dr. *Lower's* Experiment is thus ; If you open the *Vena Arteriosa*, which receives the Blood out of the right Ventricle, the Blood differs nothing in colour from the Venal, but its curdled part looks every whit as black ; but if you open the *Arteria venosa*, as it is entering into the left Ventricle, it has the perfect colour of arterial Blood, which shews, that as it owes not the colour to the left Ventricle any more than to the right, so it must receive that alteration in the Lungs : in which the nitrous Air being diffused through all the Particles of the Blood, is intimately mixed with it. For if there be any such thing as a vital flame (says Dr. *Gibson*) though the Blood, or Chyle rather, be instead of the Oyl or Matter whereon it feeds, yet it owes the continuance of its burning or life to the Air. But this scarlet colour is owing meerly to the mixture of the Particles of the Air, with the Blood in the Lungs ; for the venous blood itself, when extravasated, appears of a scarlet dye in its surface, which is meerly from its being exposed to the Air : for if one turn the congealed Blood in a Porringer upside down, the bottom, which at the turning is blackish, will in a little while turn to a lighter red. So that it plainly appears from hence, that the Blood passes through the Lungs, for no other end, but that it may be there impregnated with Air, which the left Ventricle of the Heart afterwards forms into vital Spirits. And from hence is the chief end of Respiration, that we might breath the breath of Life, or receive in the Air as a *Pabulum* for vital Spirits, which was, and is the Opinion still of most of the Moderns ; as, *Willis*, *Charlton*, *Ent*, *Betts*, and several others, who thought that the Air was drawn in for the greater Subtilization of the Blood, and accending and continuing the vital flame. Dr. *Mayow* assign'd a double Benefit by Respiration, 1st. That the Blood by the admixture of the Nitro-aereal Particles of the Air, is fermented and freed from Coagulation : and Secondly, that the same Nitro-aereal Particles, being received into the Blood,

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are carried into the Brain, for the supply of the animal Spirits; but I say by a better and a nearer conveyance, they are brought from the Lungs, by the venous Artery, and transmitted into the left Ventricle of the Heart, to be elaborated there into vital Spirits, which then like the Sun, sends heat and motion to all around it; but if this breath of Life be but any whit stopt, how presently we cease to move. This same cause of Life and Motion, both of the Heart and Blood, arises from the Air, the Fountain and Well-spring of all Life and Motion, which will yet further be made plain by Dr. Lower's Experiment, which he makes use of against the Dilatation of the Blood being the cause of Pulsation: he drew out of the jugular vein of a Dog, about half of his Blood away, impeting by turns into the crural vein, a like quantity of Beer mixed with a little Wine, and this he repeated alternatively so often, till instead of Blood, there flowed out of the vein only, a paler *linchus* like water, wherein flesh had been washed, or Claret diluted with very much Water, and yet the Heart in the mean time remitted but a little of its former Pulsation. This Reflexion I leave to the Reader, to think coolly upon, and find if his Thought will improve it to the advantage of the present Circulation.

And though Dr. Harvey pretends to overthrow all that can be said for Air, by the following Experiment, he made not the tryal fair, and so it cannot be admitted of: and indeed, if we cannot come to make the Experiment, how the Air is transmitted into the Heart from the Lungs, we shall be upon the level with Harvey in this very Experiment. If a Man cut the Windpipe of a Dog being alive, and forcibly fill the Lungs with Air, then binding that Pipe, cut up the Breast, he shall find great store of Air in the Lungs, but none in the left Ventricle and the venous Artery; therefore saith he, if the Heart did either attract the Air, or the
Lungs

Lungs did pulse it through when the Body is alive, they would have done it much more in this same Experiment, and some Air would have been found in that Ventticle; undoubtedly there would, if at the same time the Aorta could have been bound up from letting it slip through into the Arteries. Besides, the Doctor does not tell us whether there was any quantity of Air observed in the Cavity of the Breast, and though Air may not pass into the Heart as into the Lungs, it can as easily find its way through the tender Substance of the Lungs, as the Blood does by mediation of Respiration. However, I shall offer another Experiment to answer this, upon the same Reasons, cutting the arterial Vein, and syringing some hot blood through the same, into the Lungs, none of that blood will be found in the venous Artery, nay, nor in the Lungs themselves, in passing thro' their Substance, as the Circulators say it ought to do; and if all the Blood they say should pass in Circulating through the Streiner of the Lungs, their Substance would look bloody, but we see it does not so, neither is any Blood found there, after syringing of it. But supposing this will not be granted in me, I shall observe *Harvey* close, who takes notice, that there is always less Blood to be found in the left Ventricle than the right, and sometimes he says, in the left he has found none at all; to this I shall subjoyn, that upon opening the cone of the Heart, of an Infant strangled in the Birth, I saw distinctly, the Blood press in from the Auricle, into the left Ventricle, which sensibly emitted a blast of Air at the same time, and by pressing the lower part of the Heart, the blood would readily retire; as *Erasisstratus* maintain'd in the like case, that as soon as the Ventricle was cut, and the Blood immediately succeeded, which to me appears as strong an Argument, as that of Dr. *Lowers*'s, for Contraction, when the heart clapt its sides together, and press'd his finger; besides, the Configuration of the left Ventricle argues strongly for Spirits, and not Blood, that

is contain'd therein, and the *Valves* seemed to be formed rather for the admission of Spirits, and to propel the Blood, than to let such quantities of Blood pass through them; and they being placed contrarywise to one another, to open and shut alternatively in the arterious Vein, and venous Artery, would convince any one, that as the Lungs fall and rise, they may by this means draw Blood, and transmit Air to the Heart again. And *Bartholin* speaking of the Ventracles says, *Utraque arteriosum corpus habens ad transmittendum & trahendum aerem, atque refrigerandum utrumque ventriculum.* And *Hippocrates* says of the Heart, *Præstantis artificis hoc opus, cum sit totum trahendi facultate præditum folles habet duplices, scilicet auriculas, per quas instar fornacis fusoriæ spiritum ad se attraheret. Aures sunt instrumenta quibus natura aerem ad se rapit.* And as many of the Circulators grant the pulsing of the Auricles oftner than the Ventracles, and their continuing to pulse after the Hearts motion ceaseth, (as *Harvey* himself says, that the Auricles move before the Heart, and after the Heart: but observe, that what *Harvey* calls Pulsation, either in the Heart, or its Auricles, he means Contraction, as he says thus, *Notandum est omnibus, quas voco & in auriculis & in corde pulsationes contractiones voco*) argues plainly, that they depend not on the motion of the Heart, but have some other cause independant of the Heart, and which can come from nothing but Spirits; but the Ears, though they are of a different Contexture from the Heart, yet all the Motions attributed to the Heart, are said to be in them by the Inventors, as Contraction, Expulsion and Distention: But yet if the right Ventricle, as *Harvey* goes on, continues to administer Matter or Nourishment to the left, it must be understood of something else than Blood, because the left is plentifully supplied from the Lungs; and though the right is more capacious than the left, the left has more heat and strength in it, which is not procured by the Blood alone,

but Spirits, which it receives from the Lungs, and is likewise transmitted through the *Septum*, else how could it receive nourishment from the right, which all the Antients taught, and some of the Moderns : for though the sides of the *Septum* do not visibly appear to be perforated, yet they are of such a texture of parts, as the subtile Steams arising in the Ventricle, may easily gain admittance through, for there is no need of Pipes and Canals for Spirits to circulate through always, as we may observe by several parts of the Body, which send forth *Effluvia* by Perspiration, which is not discovered by the naked eye : So when the subtile particles of Fire insinuate themselves through the vessel, and pervade the pores of the Water, which makes the Water play and bubble in its passage through it, as you may see in boyling of Water ; so in burning Fevers, the Spirits spend themselves in a dry form, and are not visible ; which you may perceive plainer in breathing sweats, by a dew standing on the surface of the skin, when you expose any part to the naked air, for by means of external air, it is refrigerated and condensed into a thick vapour ; besides, the right Ventricle (says *Harvey*) is the cysterne of Blood, and is supplied by the *pabulum* of the Chyle, from whence it is continually fed, being carried to the Heart by the *Lacteals*, which performs its progressive motion by means of the perystaltic motion of the intestines, as the nutrition of the parts require it. So *Hippocrates*, *Cor nutritur intus ex defecato atque spirituoſo illo sanguine quem ex dextro haurit conceptaculo : & dextram alimentum distribuit sinistro, & radios immittit ex secretione pura sanguinis ortos*: and saith *Bartholin*, *Dexter ventriculus attenuat sanguinem & tenuiorem partem per septum in sinistrum transmittit*: And *Hippocrates* again, *At sinister spiritum vitalem elaborat ex duplici materia, scilicet ex sanguine in dextro preparato, & per venosam ab eisdem in sinistrum expulso* ; but still if this will afford no satisfaction, but that Blood, and not vital Spirits comes into
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the left ventricle of the Heart, while life remains; I shall proceed on without laying any stress on these Authorities. The left Ventricle (says *Harvey*) seems to make up the Heart of itself, or the Heart seems to have been made for its sake, and the right as it were but a Servant to the left; therefore, if according to the Opinions even of the Circulators themselves, there be a heat, fire, or flame of life in the Heart, it must be in the Left Ventricle; and if seated there, then there must be no Blood, because no flame can exist where humidity predominates; for the right is the cause of no pulsation, but the left Cavity being formed Sphærical, strongly wall'd on every side, is more fit to concenter and resist the force of the Spirits, which the right seems not to be made for, being larger, of an oblong Figure, and of a loose and soft contexture: then it will follow, if heat and Spirits can be once allowed to arise and kindle in the Heart, that the Heart draws, as it seems to be a natural action to it, by its motion, Air and Streams from every part about it, to feed itself, and as will better be proved by *Harvey's* experiment; that if you bind the venous Artery the left auricle Pulses not; so that the Ligature every where demonstrates a motion of vital Spirits from the Center to the Circumference and back again, which is not only assisted by means of respiration, but the intestine motion shews the same; and if as *Wallens* says, there was a Palpitation felt in the *Septum*, it proves, that the substance of the Heart moves by the Spirits insinuating themselves into its Pores, and agitating the parts without the help of its Nerves; and though, as *Harvey* says, the coronal Artery sends plentiful supplies, by its many ramifications into the *Septum*, for the nourishment of the parts; yet if as *Hippocrates*, and himself affirm, the Heart be nourished from within by the Spirits, which the left attracts from the right, the coronal Artery which sends those branches into the *Septum*, may likewise bring along some quantity of those Spirits which it transmits through its Capillaries into the

Septum; and indeed the Anastomoses or Inosculation of the Coronal Arteries with one another quite round the Heart, would persuade one they were so contrived for the conveyance of something else than blood. [and I would have the Reader observe, tho' in the Heart and several other parts of the Body, more particularly the Brain, there are inosculations of Arteries with Arteries, yet there can be nothing of that kind discovered of the veins.] Besides, the situation of the coronal Artery being placed in a small declivity, behind the semilunar Valves, and below a certain protuberance in an oblique situation; from whence it follows, it cannot be continually distended to receive the blood expelled from the left Ventricle; for the semilunar *Valves* are so formed and placed at the passage out of the Heart into the Arteries, to agitate and divide the Particles of the blood, and make a due mixture by means of that Circumgyration or circular Motion; hence the upper part is rendred Concave, by means of the pressure and the lower Convex. Again, there are other *Valves* to hinder the return of the blood call'd Mitral, or Three-fork'd; but to plead more convincingly on this head, to shew there is no such thing as blood in the left Ventricle of the Heart, whilst Life is in its vigour, open the left Ventricle of the Heart of any Animal strangled, and you will find no blood at all in it; for this reason, because the Suffocation causes a cessation of motion all at once, and the blood by this means stands still in its place, and cannot so easily run into the Ventricle, as when motion ceases by degrees, and the spring of the Spirits is grown languid and weak; whereas in the strength of health, it keeps the blood in the Ear from running into the Ventricle, by its elasticity and spring, which a long weakness or decay relaxes, so that it hath not force enough to repel or keep back the blood. If any of these reasons urged for the Spirits existing in the left Ventricle, rather than the blood, can be admitted of, then there will
 need

need but little to be said against Dr. Lower's Reasons for the Heart's moving by means of the animal Spirits. However, I shall instance that tryal of cutting the Heart to pieces, which will move a great while afterwards, and which it could not perform, if that Motion and Contraction said to be in the Heart, depended upon the influx of the animal Spirits, conveyed thither by mediation of the Nerves: Besides, I know none that have yet given any satisfaction to the World, what these animal Spirits are, or where to be found; but if we must admit them upon Authority, without any other proof than imagination for their existence, I hope others will not quarrel with me, if my thoughts prove as airy and fantastick as those that lived before me. Harvey tells us according to his Doctrine of gradual formation, that the *punctum saliens* is the first motion of the Heart of the *fetus*, before the animal Spirits can be supposed to exist, or at least, before the Brain is capable of elaborating animal Spirits, and such quantities as are required to supply the Nerves with, for such a work as Expulsion and Contraction; but supposing, with the Moderns, that all the parts are formed at once, and that the *Embryo* is as entirely perfect in the Egg as afterwards, and that what Harvey call'd Formation, is only an increase of bulk in the parts, and perfect Vegetation: I say, granting this, we must remark, that there is still a weakness of some particular Parts and Organs, that require longer time, e're they are fit for use, and to assist the other parts of the Body, as the Lungs, in the *fetus*, are of no use till exclusion, the Feet of humane Creatures, and the Tongue, and several other parts might be instanced in; as more particularly the *Testes*, which the Brain, supposing it formed, may be compared to, as not able to elaborate Spirits till such time, and if we find to our Senses, that the Heart moves first, before it receives Spirits from the brain, therefore we may reasonably suppose, that they are not animal, but vital Spirits, that move the

Heart.

Heart. So when we run fast, or work hard, or are in pain, we are out of breath, and find a constriction in the breast, and oftentimes a palpitation of the Heart, and grow faint and languid for want of Respiration, and the motion of the Heart intermits considerably, as *Lower* observes; and both the Heart and Lungs being then hard put to it, beat and labour themselves, as may be seen by the flanks of a Horse after hard riding: the reason of this faintness and hard labour of the Heart, is, that by the violent and swift motion of the parts, great loss of vital Spirits is made, so that the Lungs and Heart are obliged to make their greatest efforts, to supply that wast and loss made by such violent Motion. Again, from the same reason it is, that a Person unused to exercise, shall be presently weary, and puff and blow by the least motion, because the particles of Air cannot be so easily transmitted through the Lungs for the supply of the Heart, with Spirits proportionably to those bestowed upon the parts unaccustomed to motion; and for the same reason, the breathing of a Horse or Man, and using exercise, encreases their strength, when they have occasion for a quicker Motion, for then by use, the vessels are adapted for the easie reception of such quantities of Air, as is necessary to be spent upon the parts in that time. And whence came the hard compression of Dr. *Lower's* finger, but from the great effort of the Heart and Lungs, to press and squeeze out as much as possible, all the Spirits they suck in by dilating; but the Spirits not coming in so fast as they are sent forth, and as they are wanted in the parts, is the reason why there is such a defect in the Respiration, and that we are forced to stop when we overact our selves, or move quicker than our breath will permit us. Now it is plain from hence, that this motion of the Heart is caused by breathing in and expelling these Spirits, and that these

Spirits

Spirits coming from the Air, are not animal, but vital Spirits. It is manifest also, that the Heart moves not, and expels not by animal Spirits, because the Head is clear of the labour which the Heart and Lungs undergo all the while. If still it does appear that there is a regular Circulation into both Ventricles of the Heart, and through the Lungs, as has been taught; yet I deny still that any of the Circulators ever yet proved a total Circulation, but whatever has been offered, proves no more than a bare motion of the Blood, which is not here denied, but the manner of it, and that in *Circulum*; for they every one seek for several reasons of that Motion, and for the orderly Pulsations by Intervals, which all acknowledge should be performed by that Motion, which none yet have any ways demonstrated, nor have attempted to account clearly for the circulating of the Blood from the Arteries, into the Veins; but leave it in the extremities to get back again, which it must do by the Veins, as well, and as soon as it can, for it has lost its pulsifick faculty in the Veins, and there is no Contraction or Expulsion, to carry on the current of the Stream. Some have proposed an *Anastomoses*, which *Harvey* wholly explodes; others, that it is performed by the Mediation of the Glands; which I would desire any one to explain to me, and then see whether it will answer to the expeditious percolation, that is required according to the circulating System, which will not admit the blood to stay too long upon the parts, for fear it should do some service, for which the Circulation seems not designed; for then Diseases, however some, would ere this have been better accounted for, and consequently, better and sooner cured, than it does yet appear they have been since the knowledge of Circulation. For if the Antients without this secret, were as happy in their practice and account of diseases, it shows there is no truth in Circulation, since the Conclusions drawn from

it, and the several Hypotheses built upon it, prove of no service to the cure of any diseases, more than what were performed without this knowledge. For this I cannot devise any necessity for a Circulation, either for the maintenance of the parts with aliment, or equal distribution and continuation of heat and motion, to all the parts of the Body alike: But then again, what one would think should stagger the Faith of the Circulators, from believing that the Veins return all the Blood brought to them from the Arteries, is the several inosculation that is found of the Arteries, with one another in the Brain and Heart, and other parts; so that if that Office of a Circular motion be performed, it is sometimes done by the Arteries themselves; nay the *Porta* which is reckoned a Vein, performs the duty of an Artery: and so I shall prove some other Veins do the like, when I come to consider a more immediate passage for the Urine; and if you make an injection into one of the Coronal Arteries, it will run into the other, which seems a plain Proof, that those Arteries may be as well designed, as further is shown from their situation, to feed the Parenchyma of the Heart, with Spirits emitted into the great Artery, out of which both the *Coronarie* Spring; and all Anatomists have hitherto agreed, that the Heart it self is not nourished by the Blood, or Chyle brought into its Ventricles; in like manner the Veins communicate with one another, and not with the Arteries in the Heart, that this leaves it beyond dispute, that what Blood they are supplied with, must be sucked up from the very Substance of the Heart, and not by means of any *Anastomoses*, Inosculation or Communication of Glands, which were never yet pretended to be in the Heart; and therefore notwithstanding the specious pretence of the modern Circulators, that see the very same Globules of Blood, as they say move from the Extremities of the Arteries,

Arteries, to the Capillaries of the Veins in a Fishes Tail: they must here confess no such thing can happen, when they see the Veins manifestly inosculate with the Veins, and the Arteries with the Arteries. Besides, against these quick-sighted Gentlemen, I must ask to what end is Circulation at all, if not intended for the nutrition of the parts? And therefore it is necessary to admit, that the Blood is extravasated out of the capillary Arteries, into the pores of the substance of the parts, on whose nutrition part is to be spent, and the remainder imbibed by the Mouths of the Capillary Veins: because else, if part of the Arterial Blood did not issue into the substance of the parts, they could not be nourished by it; for while it is in the Vessels it cannot nourish them: and since the Vessels themselves are not nourished by it, but by Capillaries running through their Coats, we cannot suppose the substance of the Muscles can be, with the Blood being let through it. But seeing this way of transfusing of Blood through the substance of the parts, won't answer the Modern System of a hasty Circulation; nothing now will serve them, but the Arteries must be every where continued to Veins; and this they are sure they see, though I can demonstrate to the contrary in a Hundred places, some of which I have mentioned, and will appeal to all Anatomists in, though the most accurate have not yet been able to make such Discoveries as they pretended to, or find out these *Anastomoses*; for what are yet discovered of that kind, seem to be quite contrary, *viz.* of one Artery, and one Vein with another, rather than of an Artery with a Vein; but if the Blood supplied all the Body by its Circulation, it would constantly continue to do so, without Interruption, and with less supply abroad; and again, if it was so necessary to convey Life and Aliment to every part, it would of consequence follow, an interruption of that Circulation would not only endanger Life, but inevitably procure

certain Death. But on the contrary we find, when that circular motion contended for is stopt, not only life, but the parts themselves wherein the motion is disturbed, are still maintained fresh and vigorous as before: To prove this, I shall appeal to the tryal of Amputation, when the Leg is cut off above the Knee, and the Extremities of the Arteries tyed up, and the Mouths of the Veins closed: I would ask the Circulators, which way the Blood returns again by the Veins, since the usual Passages and Communications are intercepted; therefore if the Blood must continue still to circulate there, they must have recourse to some extraordinary ways, that nature has provided against such an exigency; and there are but two in this case to be thought of, either by themselves or any body else: The first is, that the Blood must pass through the interjacent Flesh, and work its way out of the descending Vessels, and then through the Tunicles of the other ascending Vessels to get into 'em, or else be suckt up again by the Veins, to which recourse must be always had by the Circulators upon all Occasions; else the Circulation could not be continued in the best State. But first, it cannot pass out through the descending Arteries, or into the ascending Veins, because both are either tyed or Seared up, so that the Blood is stopt any further progress there: And Secondly, if it did issue out of the Vessels into the Parenchyma, and pass through the substance of the Flesh, either the heat coming out of the Arterial Blood, always acknowledged, replete with Spirits, would tumifie the part, and cause a continued Inflammation, which seldom or never happens on that occasion, or else if the party could avoid this inconvenience, and that certain danger of a Fever, the Blood could not possibly be absorb'd into the Veins, in that time allowed for the Circulation. The next way to be thought on is, that the Blood must return by the same Canals back again, till it meet with

with several smaller Ramifications, still to convey it into the interjacent Flesh, to be absorb'd up by the Veins, which still meets with the same difficulties as before. And then those Vessels which before carried Blood to the extremities of the Feet, must lose their office and cannot be made use of because others of less capacity are forced to distend themselves, to receive their Quota's sent to them, for the nourishment and use of the whole; for I do suppose the same quantity of Blood, is still sent to the parts as before, the Heart knowing nothing of the loss of the Leg, continues, on her wonted Bounty: Besides if the Blood, as it must do if it continues the Circulation, be conveyed by other ramifications of the Arteries, not cut off and intercepted by the amputation, those other Vessels must lose their Office, and so close up; at least betwixt that part where the Blood finds its first exit out of those Canals into others, and the Amputation; and the ascending Veins must entirely lose their use, till other Vessels are inserted into them again, which we find contrary to experience; for if you prick the Extremity of the Member cut off, you shall find it bleed, and not only so, but in laying the parts open, you shall find both the Veins and Arteries, which were Seared or dried up in the Amputation full of Blood, to their utmost Extremities. Then again, if the Circulation could distribute Heat and Motion equally to all parts; cold would not seize so easily upon the extream parts, any more than they would do nearer the Center; for that strong Expulsion pretended as able to drive on the Circulation through the whole Body, would with the same strength and vigour impel Heat, and the Motion ought to be as quick in the fingers ends as the Heart; and though such great quantities are carried on through those parts, yet proportionably to the quantity, the Celerity and Heat ought to be therein the same extream parts, as the Heart itself.

I hope from what has been delivered, the Tide of Circulation won't run so strong, but some may withstand the Stream, and suspend their Judgments for a time, till cooler thoughts bring them to Reflexion; and then I Question not but to stem this Torrent, by raising more Arguments of Weight and Validity against it; in the mean time I shall offer the following. If then there be no Circulation, say you, what is that motion that every body sees and feels in the Blood; and how will you account for the Systole and Diastole of the Heart, and the pulsation of the Arteries, if there be no contraction and Expulsion, either in the Heart or Arteries? I answer and say, There is a motion in the Blood, and of the Blood, but not in *Circulum*; but as there are Spirits vital or aereal, call 'em which you please, that kindle and exist in the Left Ventricle; and that these Spirits need no Proof, because they are allowed of by all Mankind, that ever writ of the Nature of 'em, from *Hippocrates* amongst the Antients, to the last of our modern Circulators; *Bar. de Moor*, who acknowledges their *impetus*, though afterwards says, the *Pondus* of the Blood is capable of performing all the Offices or Functions of Voluntary motion without 'em. I say these vital Spirits, though they perform not an exact Circulation, yet they move from the Center to the Circumference; and in some Measure are attracted from the Circumference, to the Center again; but the *Pabulum* of the Fire, or flame of Life, is the Air we constantly receive and Breath in; which irradiating through the Sphere of the Body, affects every part with its Beams of heat and motion: as we may be more sensible of, in that nice Organ of sight; for we may perceive that subtile Spirit, spend itself at the Eyes, by the weakness thereof, in the too great use of them, and especially, by looking at far distant objects, which strangely weakens the Eye sight; and I shall only offer the

the following Experiment at this time, to illustrate in some Measure, what sort of motion that is in the Blood, that none may depart hence but with this satisfaction, that if he thinks any thing has been offered here with strength of Argument sufficient to convince him, that the Circulation is not without its difficulties, if not inconsistencies, here is something further proposed, in Order to establish a motion more familiar to Nature, and not inconsistent to Reason. Upon this *Easis* I shall hereafter endeavour to account for voluntary motion, the Pulsation of the Heart and Arteries, and all the several *Phænomenon* shown by the pretended Circulation. For the Reason that the Blood is in a constant motion, and moves always from the Heart, or one way towards the parts, is, that the Spirits that flow from the flash or flame of Life when it riseth, pass not away all at once so suddenly as the Heart swells and riseth in the Puff or Blast, but leisurely, by reason of the straightness of the Chinks or Valves of the great Artery, which do not open and let those Spirits through together, but each of the Valves interchangeable opens and shuts as by turns, and so letting through the Spirits by small puffs continually, they blow into the Blood as with a Threefold Bellows, which seems progressive though the Blood does not shift place, as you will see by the Experiment: for if that which moves the Blood, was sent forth out of the Heart at once, as is pretended by the Doctrine of Expulsion, the Blood would not move always, but there would be an interruption during the Diastole, or while the Heart was filling itself again, and so could not possibly circulate so swiftly as assigned; then the rising of the Spirits in the Heart which swells it up, pass away by little and little through the Three Valves of the great Artery, lest the too great force, if emitted in larger Streams should impel the Blood, and thrust it out of its place: for a gust or blast of Air rising in the Heart and sent into the Arteries, is acknowledged by *Harvey*, when he says something

thing is breathed out of the Heart into the Blood, and if there be any thing like a breath, what can it be but vital Air, which blows through and pervades the Blood, and moves it in its Passage, as is proved thus. Take a Tube of Glass about Six or Four Foot long, of half or one Inch Diameter, clos'd or stop't at one end; and having near that same end, a short Spout starting from it, of about Three Inches long, and as big as a Goose quill, whose Mouth must be stop't likewise with wax, or some other thing: fill up the Tube with Water, and lay it along upon the Ground Horizontally; but so that the spout may stand upwards, or vertically; then fix a Bellows to it, at the other open end, and blow hard and you shall see that if the Bellows have but one Orifice in their Pipe, and the Pipe be wide enough, they will force the Water out of the spout into the Air, and so drive it all away; but if the Bellows have 2 or 3 or more small holes, at the end of their Pipe, and be double to blow always, they will send forth through those holes, but slender Fillets of Air which will run through the Water, as far as the other end of the Tube and pervade it, and make it to fluctuate, bubble, and play in their Passage, and leaving it behind them, go out at the open spout, as by holding it close by the Mouth will be felt. By which means it doth appear, that the Water in the Tube, and the Blood in the Vessels, consequently are not thrust forward and out of their place by the Air and the Spirits, since they remain full, but that they agitate them in the making their way through them, so that they are but seemingly moved forwards, as the Surface of any Waters upon the blowing of the wind upon them. See Fig. the 4th.

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